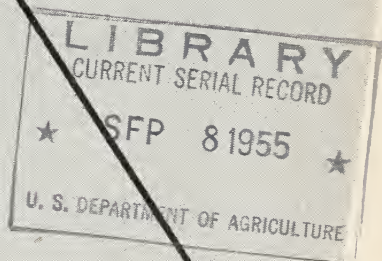


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The Coloring
or Degreening
of Mature Citrus Fruits
with **ethylene**



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The Coloring or Degreening of Mature Citrus Fruits With Ethylene¹

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INTRODUCTION

WHY CITRUS FRUIT IS DEGREENED

Early oranges such as the Parson (Parson Brown), Hamlin, and Navel; the Satsuma and tangerine; and grapefruit attain an acceptable taste and become legally mature before they fully develop the typical orange or yellow color associated in the public mind with ripe citrus fruit. In the warmer districts citrus fruits of any variety, growing on the inside branches of densely foliated trees and shaded by the foliage, retain much of their green color even after they become fully mature. Most of the green-all-over but ripe Florida Valencias are those that failed to degreen in winter because of shade, warm locations, or both. In the cooler belt of both Florida and California, exposed or nonshaded Valencia oranges develop almost full color in the winter and become mature in early spring, but have a habit of re-greening, particularly at the stem end, if allowed to remain on the tree until late spring or summer. Even grapefruit sometimes remain green in the spring, or regreen and require the coloring treatment to make them marketable. Since rind color is an important element in consumer appeal, it is highly desirable that the appearance of the fruit match its eating quality throughout its marketing season.

Immature fruit should not be degreened with ethylene because the treatment will not improve its quality and such fruit would have a bad effect on the market. Also degreening must be done carefully as too much ethylene, prolonged degreening, or improper temperatures or humidities may increase decay or cause "gas burn" or "aging."

HOW CITRUS FRUIT IS DEGREENED

Green mature citrus fruit is usually degreened commercially by exposing it to ethylene gas. This gas occurs in effective quantities in the pungent lachrymatory fumes from specially adjusted kerosene stoves and in ordinary illuminating gas and in small quantities in acetylene, propylene, butylene, and other gases produced from incomplete combustion of organic matter. It is also produced by some fruits when they ripen and by certain molds.

Ethylene is produced commercially in an almost pure state and may be obtained as a compressed gas in steel cylinders. The gas may be applied to fruit in the coloring room either in intermittent doses at

¹ This publication is a revision of and supersedes "Coloring of Mature Citrus Fruits With Ethylene," by J. R. Winston and R. W. Tilden, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Dept. Agriculture.

intervals of several hours or in a continuous flow by the "trickle" method.

Originally most fruit was colored by fumes from kerosene stoves. This method is not now in general use because compressed gas is more convenient. With kerosene there is also danger of fire and the possibility of kerosene fumes injuring the rind of some of the early fruit, especially tangerines and Satsumas.

The well-established term "coloring" as used for citrus fruits may convey an erroneous impression. In reality "coloring" for citrus fruit is a chemical stimulation of the natural degreening processes. The presence of the coloring agent, ethylene gas, under favorable conditions hastens the natural breaking down of the green pigment (chlorophyll) in the peel and reveals the yellow or orange-yellow carotenoid pigments that were previously masked. There is no actual addition of color other than possibly a slight intensification of the orange-yellow pigments. "Coloring" actually is a selective decoloring process. It does not sweeten or otherwise ripen the fruit.

A search has been underway for years for a compound that will accelerate ethylene activity and shorten the length of exposure necessary to color the fruit, but nothing has been found which degreens oranges more rapidly than ethylene alone.

FACTORS AFFECTING COLORING

CONDITION OF THE FRUIT

The manner in which fruit responds to treatment depends largely upon its innate qualities, its texture, the way it has been sprayed and fertilized, the root stock upon which it is grown, and other factors. For example, thinskin, fine-textured fruit of the Pineapple orange variety, grown on rather heavy soil, colors much better and more easily than coarse-textured fruit of the same variety grown on poor soils. Sour-orange root stock usually produces fruit that has a better color than fruit grown on rough-lemon root stock.

Oil sprays applied in late summer and early fall retard the rate of development of color in fruit on the tree as well as in the coloring room. Parathion, the new substitute for oil sprays, apparently does not impede color development either on the tree or in the coloring room. Fruit from trees that have had sufficient potash and phosphoric acid fertilizer and secondary or trace elements assume a richer and deeper color when mature than fruit from trees showing acute deficiencies of such secondary elements as zinc and magnesium. Fruit from trees with rank green foliage resulting from overfertilization with nitrogen do not color as readily in the fall as fruit that has not had too much nitrogen. Similarly, orange trees receiving high (excessive) amounts of potash produce fruit which when ripe is greener in color than that grown on a low potash diet.

DOSAGE OF ETHYLENE

The minimum effective concentration of ethylene has not been determined. It is known, however, that 1 part in 50,000 parts of air, maintained continuously, is as good as the intermittent application of greater concentrations. When the intermittent method is used, the

gas is applied from 2 to 4 times a day (morning and night) at the rate of 1 cubic foot to 5,000 cubic feet of storage space. No allowance is made for the space occupied by the fruit. When the "trickle" or continuous method is used, it is applied at the rate of 1 or 2 cubic feet to 3,000 cubic feet per day. Only enough gas to color the fruit satisfactorily within a reasonable time should be used since an excess of ethylene, if accompanied by insufficient ventilation, is likely to stimulate stem-end decay.

TEMPERATURE

The optimum temperature range for coloring grapefruit, seedy oranges, and tangerines appears to be 82° to 87° F. For Satsumas and Washington Navel oranges it is a few degrees lower. In California, a temperature of about 75° is usually used and never over 80°. Fruit colors slowly below 80°, and 90° is the maximum that can be used safely. Some fruit flavor is impaired through loss of bouquet, and off-flavors may develop if the temperature is held much above 85°.

High temperatures, especially when accompanied by high concentrations of ethylene or excessively long coloring periods, accelerate development of "aging" and "burnt stems," a discoloration of the rind in the stem area. While this damage is likely to occur in the fall when fruit retains much of its green color before picking, it is more common in the spring when fruit—especially Valencia oranges—regreens on the trees. The finer the fruit quality, the more susceptible it is to "aging."

High temperatures may be used for short periods with cold fruit that is to be warmed quickly. In general it is desirable that the temperature of the fruit be brought to 80°–85° F. within a few hours, but at an average rate not exceeding 5° per hour. The use of live steam is usually necessary to accomplish this in cold weather.

The temperature of the fruit as brought from the grove varies, depending on the time of day picked, whether grown in the sun or shade, and air temperature. Temperature may be determined by inserting fruit thermometers into some of the fruit, provided enough samples are used, or by simply closing the room when it is filled with fruit and starting the blowers (all heaters turned off). In a few minutes the top air temperature will be approximately equal to the average temperature of the fruit.

HUMIDITY

The optimum relative humidity is, in general, 85 to 92 percent; usually not lower than 90. Low humidity usually does not retard coloring but, if it is too low, the fruit becomes soft and wilts, and the loss from reduction in packout may be 10 percent or more. Low humidities accelerate aging and brown spotting of oranges, especially around the stem where the skin is tender. It is commonly called "burnt stems," "gas-burn," or "scald," and usually occurs in early fall and midspring to late spring. The same "gas-burn" may be caused by dry air alone. Humidities that are too high favor decay development and at certain seasons cause fruit to lose stem buttons. Fruit kept wet with condensed moisture colors very slowly and is likely to decay.

TIME REQUIRED FOR COLORING

The time required for coloring depends to a great extent upon grove practices, variety and quality of the fruit, weather, and available equipment. With improved facilities and methods 48 to 72 hours are required to color yellowish-green oranges at the beginning of the season if they have not had oil spray in recent months. Only 36 hours or less are required for oranges picked later in the season, except regreening Valencia's, which require longer. Oranges almost fully colored are improved in appearance by 12 to 18 hours exposure to ethylene. Grapefruit requires 12 to 24 hours less than oranges.

Under no condition should Florida citrus fruit be exposed to ethylene for longer than 64 hours, but in central California the earliest pickings of Navel oranges may require 72 hours. Since fruit continues to degreen for some time after it is removed from the coloring room, it is neither necessary nor desirable to leave it in the coloring room until all the green has vanished. Average fruit with a slightly greenish cast on removal from the coloring room may be expected to complete the degreening process before it gets to market.

After the fruit has been colored it should be treated with an effective decay inhibitor, packed, and chilled to about 50° F. as soon as possible. Cooling may be accomplished effectively during transit in fan cars, given initial icing and one re-icing.

When a room is filled with fruit from several groves or from several blooming periods, some of it colors more rapidly than the rest. The tendency is to pack the fully colored fruit and return the rest to the coloring room or send it to the processing plant. Such fruit is usually referred to as "set backs" if returned to the coloring room. It almost always develops heavy decay because of the excessively long exposure to ethylene. When "set backs" are washed and waxed before they are sorted out and returned to the coloring rooms, they do not color properly and are more subject to scald and decay. Merely washing (scrubbing) fruit before subjecting it to ethylene causes it to color more slowly.

VENTILATION

Ventilation is necessary to rid the coloring room of waste gases given off by the fruit, to reduce excessive concentrations of ethylene, and to replenish the oxygen. The amount of ventilation depends largely on the amount of ethylene used—the greater the amount of gas the greater the amount of fresh air needed. Too much fresh air is undesirable because the gas equilibrium, temperature, and humidity are upset and more heat is required. However, it is better to err in the direction of too much fresh air than too little, since too little air movement may result in heavy decay. For best results, ventilation should be continuous throughout the coloring period whether the ethylene gas is introduced intermittently or by continuous flow.

The size of the fresh air intake aperture differs with the size and tightness of the room and the type and speed of the blower. For tight, heavily insulated rooms of one car capacity (about 2,500 cubic feet) the aperture should be 6 to 8 square inches. Larger openings are required for larger rooms. Somewhat larger openings may be necessary at the first and last of the season because of a rising tem-

perature tendency during warm periods. No special openings are required for rooms with drop curtain sides or ends since ventilation occurs through many small openings.

In a partly filled room the slatted floor of the unfilled section should be covered (a canvas is convenient) to force the air through the stacks, especially in cold weather.

RESULTS OF PROPER COLORING METHODS

APPEARANCE

The fruit should be almost as firm at the end of the process as when it entered the coloring room and color should be greatly improved. Fruit should not be wilted, dried, or aged if proper humidity has been maintained. The color of midseason, thinskin, smooth-textured Florida oranges should be a deep, rich orange cast. Color need not be fully developed when fruit leaves the room since it will develop satisfactorily unless checked by exposure to cold temperatures immediately after removal. Even at low temperatures degreening continues slowly.

FLAVOR AND EATING QUALITY

Under proper conditions, the effect of coloring on flavor is so slight that many people can detect no difference in flavor even when gassed fruit is compared with fruit fresh from the tree. Fruit loses freshness as soon as it leaves the tree and the loss is hastened by prolonged exposure to high temperatures; therefore, it is important that the coloring be rapid. Total soluble solids, acid, and vitamin C content of the juice are not materially changed by coloring treatment.

KEEPING QUALITY

When the fruit is properly handled through the coloring process and immediately cooled to about 50° F., there is little if any increase in decay within a reasonable time for marketing and consuming. Usually stem-end decay can be greatly reduced by treating the fruit with sodium ortho-phenylphenate-hexamine solution, or by packing fruit in crates with biphenyl-treated liners or in biphenyl-treated cartons.

The double treatment—sodium ortho-phenylphenate and biphenyl—is still more effective and preferable when fruit is not to be consumed quickly, as in overseas shipments. Sodium ortho-phenylphenate solution is likely to cause rind injury unless hexamine is added. Biphenyl is effective and safe despite an unpleasant odor for it does not affect the fruit taste and the odor disappears when the fruit is unpacked.

Early in the fall the stem buttons of the fruit loosen, especially grapefruit, and a good percentage of them fall out during the washing process. Fruit that loses its stem buttons during the packing process is much less liable to stem end rot than fruit with buttons adhering, but no practical method has been devised for removal of those buttons not removed by the brushes. Button removal has no influence on other types of decay.

COST

All elements of cost except the coloring gas and its application are the same regardless of the gas used. Ethylene is several times cheaper than kerosene fumes. The "trickle" or continuous method of applying ethylene is much cheaper than the laborious "shot" or intermittent method. Ethylene is supplied in a steel cylinder, holding about 28 pounds of gas or approximately 375 cubic feet. A tank of ethylene costs about \$20 a cylinder, or roughly 5.3 cents per cubic foot, or 5 to 10 cents for a 1-car room per day. A cylinder of gas should color from 30 to 60 cars of fruit or more if not used in excessive amounts.

EQUIPMENT AND MATERIALS

COLORING ROOM

The ethylene treatment is perhaps most effectively applied in rooms with insulated outside walls, adequate ventilation and air circulation, and optimum humidity and temperature for rapid coloring. However, degreening may be accomplished in mild, humid weather under a tarpaulin or in loosely constructed uninsulated rooms without fans, but the longer time required under such conditions predisposes fruit to rapid spoilage, especially in the fall when the fast growing diplodia stem-end rot disease is most active.

The coloring room, usually 2,500 to 7,500 cubic feet, is large enough to hold 1 or 3 carloads of fruit in field boxes. Some rooms are larger. They should not be more than 50 percent longer than wide since the long narrow type does not permit satisfactory temperature control.

Some rooms have a subfloor below and a slatted floor above the joists. Slatted floor boards should be 4 to 6 inches wide and spaced as far apart as possible where handtrucks are used. Floor joists of some rooms radiate from a duct or flue built against or within one of the side walls and leading up to an air-conditioning chamber.

The subfloor is omitted in many of the rooms now being built and the air conditioning unit is placed in the open space between the joists and the ground (fig. 1). In this case a flue extending through the slatted floor may be removed to facilitate trucking operations. A sheet metal cover is used to protect the unit when the flue is removed.

Newer type coloring rooms have solid floors with permanent air-conditioning units suspended from the ceiling or attached to the side walls or with movable units on casters connected to the steam, water, and electric lines by hoses and insulated cables. Such equipment is likely to be found in rooms with drop curtain partitions and ends.

The ceiling should be about $7\frac{1}{2}$ to 8 feet above the floor to allow a free space of $2\frac{1}{2}$ to 3 feet above the stacked crates.

Celotex or some similar material is excellent for lining the coloring room because of insulating properties since fruit decay decreases when a porous material is used. In the warm districts drop curtains make satisfactory partitions and inside walls. When coloring rooms are not used, these curtains can be raised to let handtrucks move fruit from the receiving platform to the dumping belt (fig. 2).

Fruit can be colored in housed-in bulk bins equipped with fans, heating, and gassing facilities, thereby eliminating the use of field

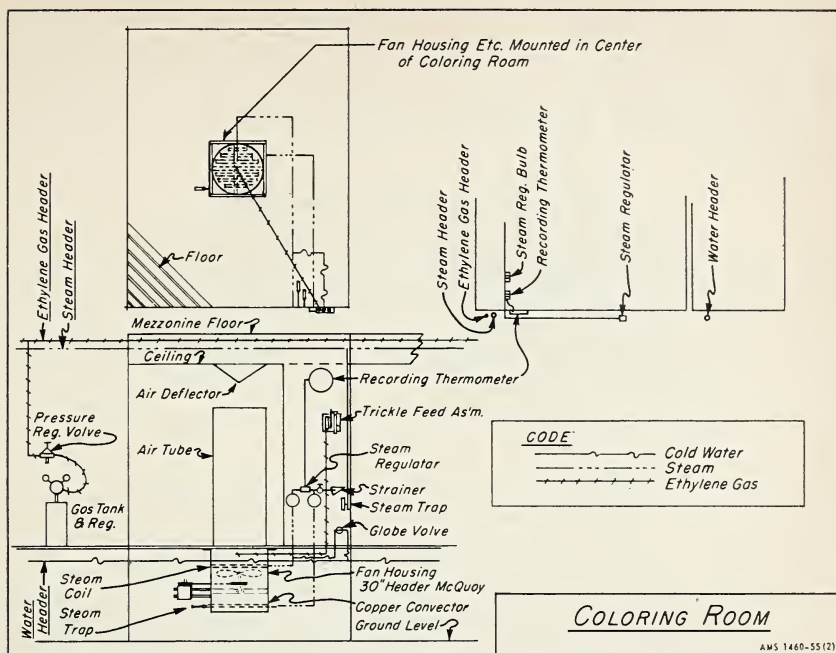


FIGURE 1.—Diagram of coloring room with air conditioning unit located in open space between the joists and the ground.

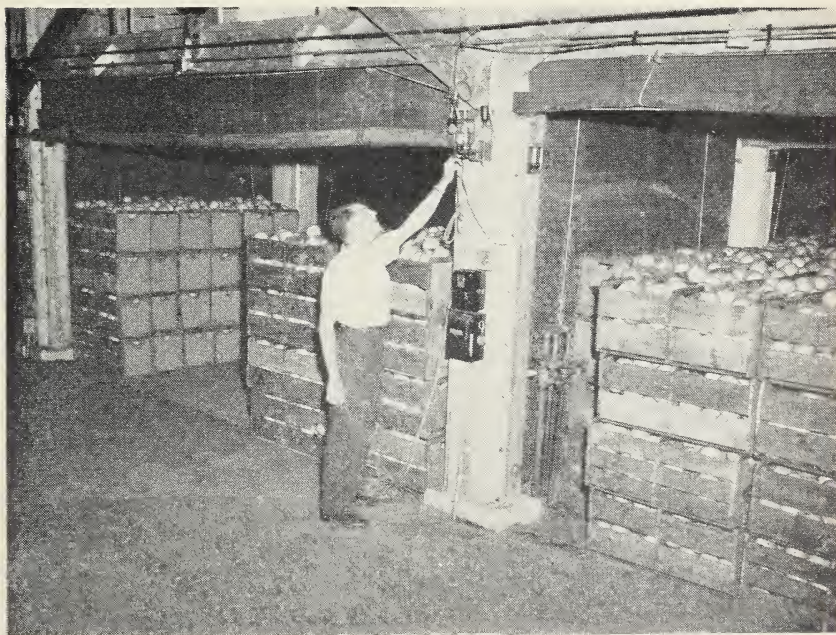


FIGURE 2.—Coloring rooms with drop-curtain partitions in rolled up position to permit handtrucking fruit.

boxes. Since the number of field boxes needed varies with the length of time fruit is held during any operation, it is advisable to color and haul fruit in bulk. However, early in the season when fruit is easily bruised and green spots or oleocellosis results, it is questionable whether the advantages of coloring in bulk bins outweigh the disadvantages.

AIR CONDITIONING CHAMBER

The air conditioning chamber is located outside of the room, either overhead (fig. 3), beneath the floor (fig. 1), or in the vertical air duct in the wall (fig. 4). Within the chamber are a steam radiator or steam coils, a live-steam opening, several coarse-water spray nozzles and a baffle for removing the larger particles of water. Besides these there is often a single fine-water spray on a separate line. The latter nozzle is usually of the type commonly used in garden spraying, but a still finer spray—such as from nozzles used for applying wax coatings on fruit—is preferable.

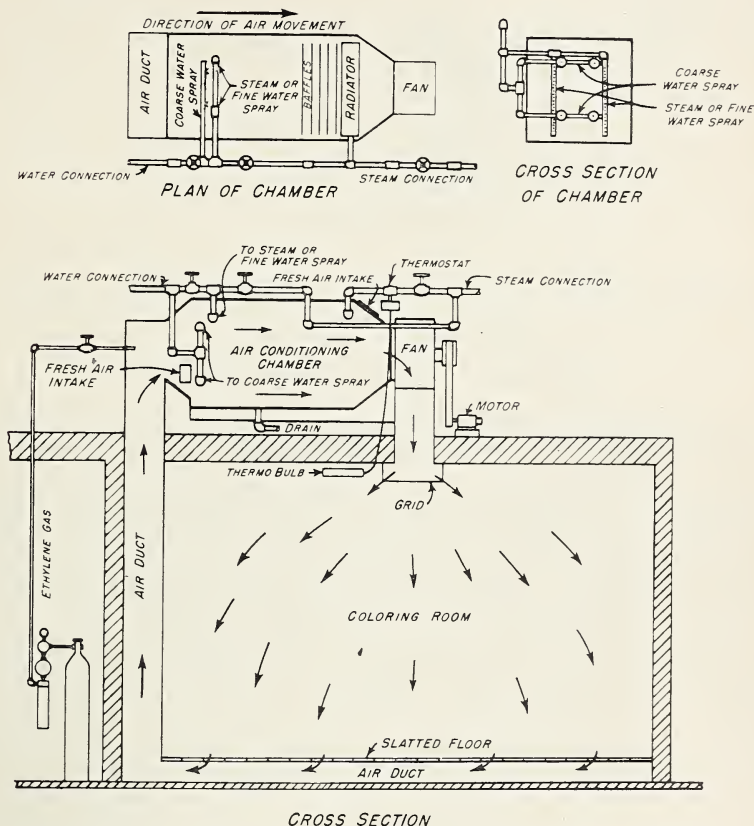
Atomizers operated from an air compressor also have proved satisfactory, especially in hot weather when use of steam is not desirable and where the water pressure is not great enough to produce a mist spray. The water sprays furnish humidity, the radiator or steam coils furnish dry heat, and the live steam jet furnishes both heat and humidity. In the better rooms a thermostat is used to regulate the steam flow into the radiator or through the live-steam outlet. Experience has shown that there is likely to be some leakage of steam through the valves controlled by the thermostats unless kept in good condition. This tends to keep the radiator hot, but in hot weather this difficulty can be avoided by placing a cut-off valve between the thermostat and the radiator. A return steam line from radiator to boiler is desirable to save fuel.

Coarse-water spray equipment is less efficient for reducing temperature in Florida than it would be in arid climates because of the comparatively high humidity prevalent there, but is useful for absorbing some heat from the air if the water has a temperature well below that of the air or the fruit. A drain must be provided to carry off the used water. The fine-water spray or atomizer is an efficient adjunct for building up and maintaining desired humidity within the coloring rooms when the weather is too hot to use live steam. The finer the spray the more efficient it is for humidifying. However, the amount of water used by this single spray cannot be expected to reduce undesirably high air temperatures.

The need for the water spray equipment in Florida is not generally appreciated because few persons realize how low the relative humidity is at midday during the fall and spring rainless periods. Between 30 and 40 percent relative humidity is not uncommon; sometimes it drops below 30 percent.

A powerful fan, connected with the chamber, blows the air through a duct against a spreading baffle and out over the ceiling of the coloring room. The conditioned air then passes downward through the fruit to the space between the slatted floor and the subfloor. It is then

DIAGRAM OF CITRUS COLORING ROOM
AND AIR CONDITIONING APPARATUS.



AMS 1461-55(2)

FIGURE 3.—Diagram of coloring room with air conditioning unit located overhead.

carried back up the wall duct in the case of the overhead chamber or directly to the conditioning unit if it is mounted under the floor.

The use of hygrometers and thermometers is necessary to regulate humidity and temperature of coloring rooms properly. The hygrometer, the most essential instrument to indicate conditions within the room, is ordinarily located within an air draft and yet convenient for reading through a glass window from outside the room. The simple Mason-type hygrometer is satisfactory if kept clean. Recording instruments are expensive and have not proved entirely satisfactory.

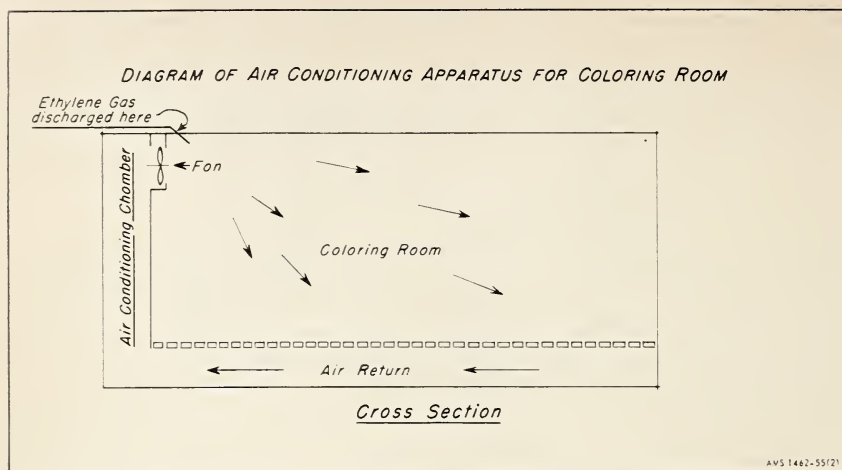


FIGURE 4.—Diagram of coloring room with air conditioning unit located in the vertical air duct in the wall.

ETHYLENE APPLICATION EQUIPMENT

Ethylene gas is introduced into the coloring rooms from the high-pressure cylinder by means of a small metal pipe (about $\frac{1}{4}$ inch) with laterals leading into each room. A reducing valve mounted at the tank maintains a constant pressure of a few pounds in the pipe regardless of the tank pressure. There is a cut-off valve near the discharge end of each lateral pipe so that the gas for any room can be turned on or off separately. Needle valves and various types of gauges are used to adjust and measure the flow of gas into the rooms.

A popular type of flow gauge, mounted in the low pressure lateral line to each room, consists of a tube submerged in water or light oil in a glass jar (bubble jar). The rate of gas flow is regulated by a needle valve and measured by counting the number of bubbles per minute passing through the liquid. Once the needle valve is set, little attention is required to maintain a uniform rate of delivery. The gas flow can be quickly varied from room to room and delivery rate can be varied by changing the pressure by means of a thumb screw on the reducing valve or by adjusting the needle valve. Thoroughly mixed with the air in the coloring room, the gas is applied in uniform concentration at all times, hence continuous ventilation is practicable.

MANAGEMENT OF COLORING ROOMS DURING COLD WEATHER

Optimum temperature and relative humidity for coloring should be established quickly, especially during cold weather. In rooms without adequate air circulation and heating facilities, the bottom fruit warms more slowly than the top and may require 24 to 48 hours to reach good coloring temperature. Relative humidity of the outside air is very low during cold weather and becomes even lower when air is heated. Consequently fruit loses moisture and becomes wilted unless

the humidity is raised. Both temperature and humidity may be raised by the use of live steam in conjunction with dry heat from a steam radiator or coils.

The following suggestions are made:

1. Raise the relative humidity to 92 percent and top air temperature of the room to 95° F. as rapidly as possible by live steam and the steam radiator or coils.

2. Reduce live steam in two or three hours if fruit temperatures have increased appreciably and relative humidity has reached 92 percent, or at the first indication that the bottom fruit is becoming wet. Allow humidity to drop temporarily until fruit is dry. Fruit should not remain damp longer than the first few hours.

3. Reduce air temperature to about 85° F. after four or five hours or when fruit temperature is about 80°, but not before fruit has dried.

4. Continue to use live steam to maintain humidity at or near 90 percent, and keep fruit temperature between 82° and 87°.

5. Use no more gas than necessary. The amount needed varies with the amount of air leakage. If fruit is likely to develop stem end rot, the room should be cleared of all gas traces several times a day by opening the doors to achieve complete ventilation. This reduces decay without retarding coloring.

MANAGEMENT OF COLORING ROOMS DURING WARM WEATHER

The temperature of the fruit when it comes from the field during warm weather is usually near the temperature of the coloring room. Little, if any, extra heat is needed and at times when the fruit is turgid, as in early fall, there is little or no need for added humidity during the first hours. Added humidity is needed, however, if an adequate supply of fresh air is being introduced. There is only slight possibility of the fruit becoming damp, and, therefore, no particular reason for alarm if the relative humidity rises to 94 percent or slightly higher for a short period. Outside air temperatures above 90° F. and low humidity are not serious since both temperature and humidity in the room can be regulated by the fine-water spray. The pulp temperature of the fruit should be kept at about 82°–86° most of the time and should not go too high. The following suggestions are made for operating the coloring room during hot weather:

1. If fruit temperatures rise too high ventilate the space above the rooms. If necessary, open doors and air the room at night when outside air temperatures are lowest. This does not delay coloring.

2. Use cold-water spray in the air conditioning chamber to reduce room air temperature when there is considerable difference between the wet and dry bulb temperatures of the outside air.

3. Fans driven by 2-speed motors should run at high speed until desired fruit temperature is reached, then use low speed. When a fan is used at low speed, the fresh air opening should be increased proportionately in very tight rooms.

4. Use the fine spray or steam to build up humidity if the fruit shows signs of wilting.

5. Use minimum amount of gas necessary to color the fruit.

COMMON ERRORS IN THE OPERATION OF COLORING ROOMS

Fruit temperatures are often judged entirely by the temperature at the top of the stack or by the top air temperature. This is misleading as the top fruit temperatures and air temperatures are raised much more rapidly than those at the bottom. It is well to have fruit thermometers in both the top and bottom boxes if air circulation is not uniform throughout the room. These temperatures should be controlled, especially in the early stages of coloring.

Humidity is often too low during the first several hours of the coloring period, moisture is taken from the fruit, and wilting and accelerated aging sometimes result. It is, therefore, important to properly humidify the air with steam or the water spray before it reaches the fruit. Care should be taken not to use excessive steam or spray. Fruit must not be drenched and that in the lower boxes must not remain wet too long.

Some inexperienced operators do not understand how to read the hygrometer (wet and dry bulb thermometers) and think that relative humidity can be read directly from the wet bulb thermometer. Relative humidity must be obtained by reading both the wet and dry bulb thermometers and referring to tables giving the relative humidity that corresponds to the temperatures. Approximate relative humidity at the air temperatures in the range used for coloring may be obtained by multiplying the difference between the wet and dry bulb thermometers by 4 and subtracting the product from 100.

Regulation of the fresh air should be rigidly controlled. Too much fresh air interferes with the temperature and humidity control and may dilute the gas to retard coloring. Too little fresh air "stifles" the fruit, permits accumulation of undesirable waste products which retard coloring, and stimulates decay. The tightness of the room, capacity of the fans, and size of the fresh air intake aperture should be properly regulated to insure optimum ventilation.

Too short a period is sometimes allowed for proper coloring and fruit often leaves the room in practically the same condition as when it arrived. In general not less than 36 hours are necessary for fruit that shows considerable green color. However, it should be remembered that coloring continues for some time after removal from the rooms and an overnight exposure produces measurable effects if the fruit is held at mild temperatures for a day or two after packing.

SUGGESTIONS

Oleocellosis or green spotting, commonly observed early in the season and usually charged to faulty coloring room operations, is really the result of fruit bruising during harvesting or hauling. Injury occurs before the fruit gets to the packinghouse. Fruit picked early in the day is much more likely to develop green spotting than that picked in the afternoon. Spotting is especially apt to occur during rainy or foggy periods when fruit is turgid. The least amount of green spotting occurs in fruit picked toward the end of the afternoon of dry clear days. Oranges are more susceptible than grapefruit

and of the commercial varieties of oranges the Parson is perhaps the most susceptible.

Without competent supervision it is not possible to color fruit without increasing the total decay (coloring increases stem-end rot, but at the same time decreases green mold rot somewhat). Coloring is a highly specialized undertaking. Too often the job is assigned to workers lacking in essential qualifications. In many houses the watchman is supposed to take care of the coloring rooms at night. Even if he understands coloring he is usually busy with other duties at the very time the coloring rooms should be receiving the closest attention, i. e., during the first 6 or 8 hours of the coloring period. Close attention to all details is essential at all times. Temperature and humidity readings should be recorded every hour or two and an inspection of the fruit itself made every few hours. Indications of trouble must be detected early and faults corrected immediately. Gas flow and ventilator openings require little attention after they are properly set, but they should be checked periodically.

Because of the peculiar requirements of this highly specialized work, it is doubtful whether persons without special aptitude or technical training can be developed into successful coloring room operators capable of recognizing and coping with the ever changing conditions of weather and the fruit itself. With adequate basic training, an alert person with energy and common sense, the latter being the more essential, can easily and quickly become quite expert in this work.

